The Enbridge Consumers Gas "Steam Saver" Program

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Abstract

This paper describes the Enbridge Consumers Gas Steam Saver Program. It gives results for a four-year period up to the end of December, 2000. It was presented at the March 2001 Energy conference sponsored by CIPEC, Natural Resources Canada and The Canadian Auto Parts Manufacturer's Association.

In Canada, medium-sized and large-sized steam plants consume approximately 442 billion cubic feet (12.5 billion cubic metres) of natural gas annually. This is 25% of all natural gas delivered to all customers. (Small steam plants and hydronic heating boilers consume another 15 percent.)

Enbridge Consumers Gas, a local gas distribution company located in Toronto, has approximately 400 industrial and institutional customers who own medium-sized or large-sized steam plants.

During the past four years, Enbridge has developed a comprehensive steam energy efficiency program called **"Steam Saver."** This program is aimed at these 400 customers. The heart of this program is the boiler plant audit and performance test.

This paper describes the fuel-saving results for 41 medium-sized and large-sized boiler plants where audits have been completed and projects have been implemented.

Introduction

Enbridge Consumers Gas is a natural gas distributor whose franchise service area includes the Greater Toronto area, Ottawa, Eastern Ontario and the Niagara Penninsula. The gas utility has 1.4 million customers including 1200 large volume customers.

In 1994, the Ontario Energy Board required the two main gas utilities in this province to implement energy efficiency programs.

In 1997, Enbridge Consumers Gas introduced the "Steam Saver Program," a boiler plant audit which is aimed at large volume industrial and institutional customers with steam plants.

Since 1997, 41 steam plants have been audited and 1.4 billion cubic feet (40 million cubic metres) of energy-saving opportunities have been identified. This represents 12 percent of the total natural gas consumed by these plants.

In 1999, several **new programs** were introduced to focus on other opportunities to save steam energy. These programs include Steam Trap Surveys, Steam Pressure Reduction, Combustion Tune-ups and Plant Metering. These new programs have identified further savings.

The role of the gas utility is to facilitate the identification and implementation of fuel-saving projects. The utility is in a unique position to do this by virtue of its existing sales force, knowledge of the market, and its reputation for providing unbiased technical assistance.

The Price Of Natural Gas

Since the beginning of this program, the price of natural gas and other fuels to large industrial customers has increased dramatically. As a consequence, the average financial payback period for the entire range of steam-saving projects identified has dropped from three years to a simple payback of 1.1 years:

Year	Burner Tip Price of Nat. Gas ($ per CU M)	Average Payback on Steam Saving Prj.
1997	$0.10	3.1 years
1998	$0.12	2.7 years
1999	$0.16	2.0 years
2000	$0.30	1.1 years

The Steam Boiler Population

Ontario is the most heavily industrialized province in Canada. With a population of 12 million people and an industrial base of some 5000 manufacturing companies (larger than 50 employees), it can be compared in size and industrial output with Michigan or Ohio.

All major industrial sectors are represented. The automotive, pulp and paper and steel industries are particularly large energy and steam users. Food and beverage processors and the petrochemical industry are also heavy steam consumers.

The Enbridge Consumers Gas franchised service area includes approximately one-third of the Province's industry and half of its large institutions.

Fuel Consumption in Boiler Plants

While the foucs of Enbridge's efforts to improve efficiency in steam plants is natural gas, steam efficiency can equally be applied to plants which burn other fuels. Any of the efficiency programs described here can be applied to oil, wood, or coal fired plants.

TABLE 1: Boiler Population for Steam Plants with Annual Fuel Consumption Greater Than 70 Million Cubic Feet (2 million cubic metres) of Natural Gas

Location	No. of Boilers	No. of Plants	Annual Gas Consumption BCF/YR	Annual Gas Consumption B CU M/YR
Enbridge	1,330	400	66 BCF/YR	1.9 B CU M/YR
Ontario	4,000	1,200	177 BCF/YR	5.0 B CU M/YR
Canada	10,000	3,000	442 BCF/YR	12.5 B CU M/YR

Note: All figures exclude large electric utility plants. BCF/YR = Billion Cubic Feet per Year B CU M/YR = Billion Cubic Metres per Year

The Steam Saver program is aimed at industrial consumers and also medium-sized and large-sized institutions such as hospitals, defense bases and universities. These facilities have central heating plants which are increasingly moving to co-generation to supplement steam production and absorption chilling to level out the seasonal demand.

In Ontario, fuel consumption in the target market (medium-sized and large-sized plants) breaks down approximately as follows:

TABLE 2: Fuel Consumed by Medium-sized and Large-sized Boiler Plants--Ontario

	Equivalent BCF	Percent of Total
Natural Gas	177	65%
Oil	50	18%
Wood	40	15%
Coal/other	5	2%
Total	272	100%

Note: Most plants burning wood co-fire with natural gas. Most oil is consumed by customers with interruptible gas contracts operating under gas curtailment conditions.

THE "STEAM SAVER" PROGRAM

The Regulatory and Financial Background
The Ontario Energy Board (O.E.B.) is the regulating agency for the two gas utilities and the electric utilities in this Province. In 1994, the O.E.B. required the gas utilities to implement energy efficiency programs for all market sectors. In 1999, the O.E.B. and Enbridge negotiated a special financial arrangement called the "Shared Savings Mechanism". This arrangement sets targets in terms of natural gas volumetric savings which must be implemented by Enbridge each fiscal year. If Enbridge fails to meet the annual target, it pays a heavy financial penalty which is levied through the rate base. On the other hand, if the utility exceeds the target, it receives a significant financial reward by the same means. The penalty or reward is directly proportional to the energy efficiency volume shortfall or excess compared to the target figure. The formula for calculating the penalty or reward is complex. In general it is based on the estimated societal benefits. Enbridge's share of the total benefit is a percentage of the total figure. This arrangement has provided a major financial incentive for Enbridge to implement energy efficiency programs.

Description of the Steam Saver Program

The Steam Saver Program began in 1997 as a single activity-the steam plant audit and performance test. It has since been expanded to include specific programs designed to achieve savings sooner, for smaller customers, and at less cost. The performance test and audit is still the largest activity but programs such as the Steam Trap Survey are generating rapidly growing results. A new program, The Combustion Tune-up Program, has received an excellent early response from customers.

The Steam Plant Performance Test and Audit

Why Do a Boiler Plant Audit? The purpose of the steam plant performance test and audit is:

- To identify fuel savings opportunities
- Provide economic data to the customer (Benchmarking)

Who Qualifies for an Audit? All customers having boiler plants which consume more than 2 million CU M/YR (70 million CU FT/YR) or more of natural gas qualify.

Who is Responsible for the Audit? After the Enbridge Energy Management Consultant (EMC) sells an audit to a customer he assumes the project responsibility for organizing the field work and coordinating the report.

Enbridge contracts with outside specialized steam engineering consultants to do the audit, but participates in the testing and site work. Enbridge supplies and maintains combustion analyzers and other test equipment.

How is an Audit Done? The audit field work and report proceed according to a standard format (which can be tailored for specific customer requirements and circumstances). Here is the standard procedure and report format which has been developed over three years:

1. ***Field Work First*** -This is a crucial part of the process. The auditors must establish a friendly relationship with the plant management and operators. There is often an air of suspicion in boiler plants because of the fear of criticism or job loss. The watchword here is diplomacy.

The Enbridge EMC spends two or three days in the customer's plant with the outside engineering consultant.

Combustion Tests are done on all boilers taking combustion and temperature readings at four or five points between low and high fire.

The boiler plant is inspected with a view to identifying problems or losses. Features such as economizers, air pre-heaters, blow down heat recovery, excessive venting and instrumentation are all considered.

The boiler plant supplies its records to the auditors. These may include a wide variety of daily or monthly operating reports, operators' logs, water treatment records and even previous test reports. Many plants have very poor records or almost none at all.

2. *The Audit Report* - The audit report is completed by the steam consulting engineer together with the Enbridge EMC who usually writes part of the report.

The standard report comprises eight sections as follows:

Executive Summary
A listing of energy saving opportunities complete with savings and capital cost estimate.

Section 1-Plant Energy History
A summary of operating data for the past year. We rely heavily on the hourly gas consumption information from the utility gas meter (The Metretek System). Combustion test results and steam plant log data are also employed. The result is a comprehensive report on fuel consumption, steam production, peaks and averages, blow down rate, water make-up, electricity and so on.

This section also includes cost data and benchmarking for the larger plants.

Section 2-Equipment List
Nameplate and rating data from all boilers and other major equipment in the plant.

Section 3-Combustion Test Data
Calculation of losses using the ASME power test code method and efficiency graphs for all boilers.

Section 4-Plant Inspection Report
Observations and comments on the plant design, equipment condition, and suggestions for improvements to save energy

Section 5-Steam Loads and Distribution
Observations about the steam distribution system and comments on the nature of loads. Spot obvious opportunities to save such as excessive venting of condensate receivers, condensate not returned, uninsulated piping and so on.

Section 6-Water Treatment
A general review of the water treatment records. Comments on blow-down, maintaining target levels of sulphite, PH and alkalinity.

Section 7-Savings and Capital Cost
Calculations showing the savings estimates for each project.

Section 8-Safety Issues
Comments on conditions such as high carbon monoxide levels in flue gas, natural gas leakage and steam leakage.

The Cost Of Doing A Steam Plant Performance Test And Audit
The following is the average direct cost of 41 audits completed to date. It excludes administrative and marketing costs.

Steam Engineering Consultant Fee	$ 8,500
Travel Expenses	$ 600
Enbridge EMC's Time	$ 4,250
Total	**$13,350**

Note: The Average Hourly Rate is $ 85/HR

Enbridge pays two thirds of the consultant fee up to a maximum of $5,000. On average, therefore, Enbridge pays the maximum of $5000 and the customer pays $3,500 for the audit.

Results Of 41 Steam Plant Performance Tests And Audits
The results of 41 steam plant audits performed since 1997 are shown in Table 3 (see next page). Twenty six of the audits were industrial customers. The remaining 15 customers are central heating plants in hospitals, universities, one national defense base and other federal government facilities.

Where Do The Savings Come From?

Table 4 (located on page 35) provides a breakdown of the results of the steam plant audits and other programs by type of project.

The **top projects** in terms of savings identified are:

Boiler Room Capital Projects
The payback on major boiler replacement projects is now 3.2 years, down from 7.5 years in 1999. Enbridge's role in affecting energy savings is to work with customers who are making major investments at the planning stage in order to provide technical and financial assistance to optimize

efficiency. Boiler sizing and selection, heat recovery, metering, and other decisions come into play.

Combustion Improvements

Combustion improvements are almost universally required. The payback on projects such as boiler tune-up, repair of burners, fuel air ratio components and blowers is less than one year.

Heat Recovery Projects

New economizers, blow-down heat recovery and condensing heat recovery projects identified the largest single category of improvement. The average payback of 1.1 years is very attractive.

Steam Distribution System Improvements and Trap Repair

Trap repairs, replacement, improved condensate return and other projects are an attractive investment with an average simple payback of 0.4 years.

New Steam Saver Programs

Several new Steam Saver programs were introduced in 1999. The purpose was to take advantage of the findings of the Steam Plant Audits which are summarized in Table 4; that is, to target the main savings areas without having to conduct an expensive study of the boiler plant. This also allows Enbridge to extend the Steam Saver Program to smaller plants and to reduce the sales/implementation cycle time.

The Steam Trap Survey

The steam trap manufacturers have considerable technical expertise in the application and testing of steam traps.

TABLE 3: Total Results Of Steam Plant Performance Tests And Audits Excluding New Programs For 1999

	Units	Metric Equivalent
Number of Plants Audited	41	____
Annual Gas Vol. Consumption	11.8 Billion CU FT/YR	333 Million CU M/YR
Annual Gas Bill	$100 Million	____
Number of Savings Projects Identified	203	____
Annual Fuel Savings Identified	1.4 Billion CU FT/YR	40.1 Million CU M/YR
Annual Dollar Savings Identified	$ 12.0 Million	____
Per Cent Savings of Annual Gas Bill	12%	____
Capital Cost of Projects Identified	13.5 Million	____
Average Payback of Projects Identified	1.1 years	____
Number of Savings Projects Implemented	39	____
Annual Gas Vol. Savings Implemented	378 Million CU FT/YR	10.7 Million CU M/YR
Annual Dollar Savings Implemented	$ 3.2 Million	____

Many steam distribution systems are poorly designed and maintained, resulting in major losses of energy in steam and condensate.

Our approach has been to team up with the steam trap manufacturers, including Spirax Sarco, Preston-Phipps (Armstrong) and Nutech (TLV) to conduct steam trap surveys.

Enbridge funds 50% of the survey cost. The survey is conducted by the supplier's technicians.

This includes tagging all traps, testing all traps and providing a critique of the system design problems where applicable.

Besides leaking traps, there are a range of common problems found:

- Condensate return pump failure and condensate dumping to drain.
- Condensate return lines too small causing back-up of condensate into coil or heat exchanger.

TABLE 4: Steam Saver Programs Summary of Results By Type of Project

NORMALIZED FUEL COST $0.30 PER CU M

NO.	TYPE OF PROJECT	IDENTIFIED SAVINGS			PROJECTS IMPLEMENTED			
		NO. OF PROJECTS IDENTIFIED	ANNUAL DSM SAVINGS CU M / YR	ANNUAL SAVINGS $	TOTAL CAPITAL INVESTMENT	AVERAGE PAYBACK YEARS	ANNUAL SAVINGS CU M/YR	ANNUAL SAVINGS $/YR
BOILER PLANT AUDITS								
1	Combustion Improvements Boiler tune-up, Combustion control repair, Burner repair, Repair existing oxygen trim system	45	6,076,909	$1,823,073	$725,700	0.40	3,065,890	$919,767
2	Boiler Room Capital Projects Replace old boiler, add summer boiler, change feed-water pump, new feedwater system, new deaerator, new flue gas uptake damper, turbine repair, controls improvements	43	7,384,603	$2,215,381	$7,022,400	3.17	2,862,507	$858,752
3	Heat Recovery and Economizer Projects Add new economizer, repair existing economizer, add new condensing heat recovery economizer, add new blow down heat recovery system	37	1,809,148	$3,542,744	$4,054,322	1.14	1,973,473	$592,042
4	Operating Changes in Boiler Room Reduce deaerator venting, reduce boiler blow-down, shut down boilers on weekends and off-hours, use existing F.W. turbine, fewer boilers operating	22	4,305,097	$1,291,529	$112,732	0.09	1,791,242	$537,373
5	Steam Distribution Piping and Condensate Improvements (Excluding Steam Trap Program) New steam piping, new condensate piping and receivers, consolidate steam piping of different pressures, repair condensate pumps, new control valves, recover flash steam from tanks, includes repairs to steam process equipment	37	6,658,379	$1,997,514	$686,500	0.34	1,020,457	$306,137
6	Building HVAC Changes and Capital Projects New air handler controls, new temperature set back controls, close building doors in winter, turn off steam heaters in summer, convert steam coils to direct firing-natural gas	7	2,535,190	$760,557	$490,000	0.64	0	$0
7	Insulation Improvements Insulate oil storage tanks, insulate steam piping	3	885,650	$265,695	$286,000	1.08	0	$0
8	Other Projects Clean boiler waterside, improve water treatment, clean heat exchangers	9	405,000	$121,500	$75,000	0.62	0	$0
TOTAL BOILER PLANT AUDITS		203	40,059,976	$12,017,993	$13,452,654	1.12	10,713,569	$3,214,071
9	Steam Pressure Reduction Central Heating Plants	6	1,814,490	$544,347	$0		1,814,490	$544,347
10	Steam Trap Survey Program	38	4,116,753	$1,235,026	$548,961		2,327,712	$698,314
11	New Boiler Plant Program	2	525,000	$157,500	$1,307,352		400,000	$120,000
12	Metering and Monitoring Program Install new steam, gas, water meters, repair and calibrate existing, install computerized data acquisition system	2	476,000	$142,800	$185,000		476,000	$142,800
TOTAL OTHER PROGRAMS		48	6,932,243	$2,079,673	$2,041,313		5,018,202	$1,505,461
TOTAL RESULTS BY TYPE OF PROJECT		251	46,992,219	$14,097,666	15,493,967	1.10	15,731,771	4,719,531

- Wrong type of trap for the application, oversized or undersized traps.
- No strainers.
- Missing piping insulation.

TABLE 5. Results of Steam Trap Surveys

Number of Sites Surveyed	38
Number of Traps Tested	4,834
Number of Leaking Traps	869
% of Traps Found Leaking	18%
Annual Steam Losses	111,751,570 LB/YR
Identified Fuel Savings	$ 1,235,025
Capital Investment	$ 548,961
Average Simple Payback	0.4 Years
Projects Implemented	19
Savings Implemented	$ 698,313

The Steam Pressure Reduction Program

This program is aimed at central heating plants where steam is produced at 100 to 250 psig, distributed to remote locations, and then reduced in pressure to 15 psig or lower.

Theoretically, energy is saved when the main steam pressure is reduced because:

- The boiler stack temperature is reduced.
- Piping radiation losses are reduced
- Leaks in traps and other sources are reduced.

The success of this measure depends on the fact that most central heating plants are over-sized. Boiler tubes and steam piping can accommodate the increase in the specific volume of the steam without undue pressure loss. We have conducted initial tests at six plants and are now monitoring the benefits over a longer period. The true savings have ranged from 3 percent of the total gas consumption to 8 percent in one case. It appears that savings are greatest when the pressure is reduced below 70 psig.

The New Boiler Plant Program

The boiler population is aging. In Ontario, records indicate that the average age of registered steam boilers is 26 years.

Most new boilers sold are for replacement, although there are a few green-field boiler plant projects every year.
Many replacement boilers are installed without proper analysis, planning or attention to energy efficiency features.

The Enbridge New Boiler Program is designed to motivate owners to plan properly and consider energy saving features. This program provides financial incentives to companies who plan to install new or replacement boilers if they include the following package of energy efficiency measures:

1. ***Right Sizing the Boilers*** **-** In the past, boiler plants were much oversized by design. This was justified on the basis of future growth. Many plant owners are now paying a high penalty for the added losses of operating the boiler plant on low fire.

Enbridge offers technical help to customers in sizing based on load analysis and fuel consumption history. We have unique expertise in forecasting plant and heating loads and apply this experience at no charge to customers who are planning replacement or expansion of boiler plants.

2. ***Economizers*** **-** Economizers can improve annual boiler efficiency by as much as 5 percent. However an engineering analysis which takes account of the load profile is required to correctly estimate the savings attributable to the additional investment required to install an economizer.

3. ***Blow Down Heat Recovery*** **-** Part of the New Boiler Plant package is to consider implementing blow-down heat recovery in the new boiler plant.

4. ***Fuel and Steam Metering*** **-** One of the most neglected areas of the boiler plant is metering. New plants are encouraged to invest in steam and fuel metering. This is part of the incentive package offered to owners of new boiler plants.

The Boiler Combustion Tune-Up Program

Unnecessary combustion losses account for nearly 2 percent of the total fuel consumed by steam boiler plants. There is an existing infrastructure

of boiler service companies who are capable of testing and repairing boiler combustion problems.

This program is designed to encourage steam plant owners to maintain the combustion of their boilers through their present boiler service companies or to do it themselves.

Enbridge has designed a program which pays the owner to test and tune-up his boilers twice per year.

The terms of this program are that the owner must submit combustion test results in order to be paid. The incentive grant is:

- $ 130 per boiler per tune-up for boilers smaller than 600 boiler horse power
- $ 230 per boiler per tune-up for boilers 600 boiler horsepower and larger.

Metering and Energy Mangment for Boiler Plants

Metering of fuel and steam is an often-neglected aspect of steam plant operation. The boiler plantshould be regarded by corporate management as a cost center.

Fuel now accounts for 85 percent of the cost of operating a boiler plant.

It is imperative in most cases that the fuel input to the boiler plant be reported regularly. This is a bare minimum for responsible cost management, yet this requirement is often not met.

Low cost data acquisition systems make it feasible to automatically collect fuel consumption and other boiler plant data and produce regular reports for management use.

The average cost of operating a large boiler plant according to Steam Saver audits of manned plants is over $5 million per year. Enbridge offers incentive grants to steam plant operators who are prepared to install metering and energy management systems.

CONCLUSIONS

In the past three years, The Steam Saver Program has demonstrated that, on average, fuel savings of 14 percent of total annual fuel consumption can be achieved. The 251 projects identified in 89 plants have shown an average payback of 1.1 years.

73 of these projects saving 554 million cubic feet (15.7million cubic metres) of natural gas annually have been implemented. This represents 4 percent of total fuel consumption. Enbridge customers are saving $4.7 million annually on these projects.

The rate at which savings are identified and implemented is growing rapidly. This is due to:

TABLE 6: Total Results Of Steam Saver Program Including New Programs to End of Year 2000

	Units	Metric Equivalent
Total Number of Plants	41 + 48	____
Number of Savings Projects Identified	251	____
Annual Fuel Savings Identified	1.7 Billion CU FT/YR	42 Million CU M/YR
Annual Dollar Savings Identified	$14.1 Million	____
Savings % of annual Gas Bill	14%	____
Capital Cost of Projects Identified	$ 15.5 Million	____
Average Payback of Projects Identified	1.1 Years	____
Number of Savings Projects Implemented	73	____
Annual Gas Vol. Savings Implemented	554 Million CU FT/YR	15.7 Million CU M/YR
Annual Dollar Savings Implemented	$ 4.7 Million	____

- The growing effectiveness of the Enbridge Energy Management consultants.
- Capital projects require an average of 18 months to implement. There are more projects in the pipeline now after four years of conducting audits.
- Recently, the rapid rise in natural gas prices which has motivated plant owners to better manage their energy costs.
- New programs introduced in 1999 were designed to accelerate the process of implementing energy saving projects. These are now showing results.

The best projects for saving energy in a steam plant are:

- Combustion improvements.
- Heat recovery projects.
- Steam trap and distribution system maintenance and repair.
- Boiler replacement with proper sizing, selection, and metering.

Steam Cost And Plant Benchmarking

The steam plant audits include a feature which provides each customer with an estimate showing the cost of steam and other plant operating variables, compared to the average steam plant. This is a useful tool for management to benchmark their operation. The average cost of steam for 15 large steam plants in year 2000 was $13.72 per thousand lb. This is an increase of 70 percent over 1999. Table 7 (see next page) gives details on average and total steam costs for these plants.

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TABLE 7 - Steam Cost

Average Cost and Performance for 15 Large Boiler Plants
Year 1999 vs. Year 2000

FUEL COST →	Cost for Year 1999 $0.16	Per CU M	Cost for Year 2000 $0.30	Per CU M

AVERAGE PLANT PERFORMANCE

Date of Audit	In-	1997 to 2000	1997 to 2001
Type of Steam Load		Heating and Process	Heating and Process
stalled Boiler Capacity (LB/H)		163,560	163,560
Rated input of "ON" boilers (BTU/HR)		113,329	113,329
Annual Gas Consumption (MILLION CU M)		14.6	14.6
includes equivalent btu value of oil			
Average Hourly Gas Cons. (CU M/HR)		1,689	1,689
Peak Hourly Gas Consumption (CU M/HR)		3,125	3,125
Operating Hours/YR		8,640	8,640
Average Combution Efficiency (%)		82.00%	82.00%
Average Plant Efficiency (%)		77.00%	77.00%
Operating Pressure (PSIG)			
Total Enthalpy at Operating Pressure			
Steam Net Added Enthalpy for Site (BTU/LB		1,204	1,204
Annual Steam Production (LB)		1,052	1,052
Average Hourly Steam Poduction (LB/HR)		369,750,784	369,750,784
Peak Hourly Steam Load (LB/HR)		43,019	43,019
Make-up Water Annual Consumption		80,451	80,451
MILLION IMP. GAL.		19.2	19.2
Electricity Annual Consumption (KWH/YR)		1,149,957	1,149,957
Average Blow-Down Rate		5.60%	56.0%
Blow-Down Heat Recovery			
Estimated Vent Losses (BTU/HR x 1000)		300	300

Steam Cost	Total Annual Cost 15 Sites Yr 1999	Annual Average Cost per Site	Average Total Cost/KLB	Annual Cost 15 Sites Yr 2000	Annual Average Cost Per Site	Average Cost/KLB
FUEL	$34,628,550	$2,308,570	$6.244	$64,928,531	$4,380,000	$11.846
Electricity	$1,184,829	$78,989	$0.214	$1,184,829	$78,989	$0.214
Water	$810,006	$54,000	$0.146	$810,006	$54,000	$0.146
Water Treatment Chemicls	$627,484	$41,832	$0.113	$627,484	$41,832	$0.113
Operating Labor	$4,555,827	$303,722	$0.821	$4,555,827	$303,722	$0.821
Total Operating Cost	$41,806,696	$2,787,113	$7.538	$72,106,677	$4,858,543	$13.140
Maintenance Costs						
Mtce. Lobor (internal)						
Mtce. Contracts incl parts and labor						
Subtotal Maintenance Cost	$3,005,028	$214,645	$0.581	$5,634,428	$214,645	$0.58
Total Annual Operating Cost	$44,811,724	$3,001,758	$8.118	$77,741,105	$5,073,188	$13.72